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A METHOD OF DECONTAMINATION OF ULTRASONIC SCALERS AND HIGH SPEED--ETC(U)  
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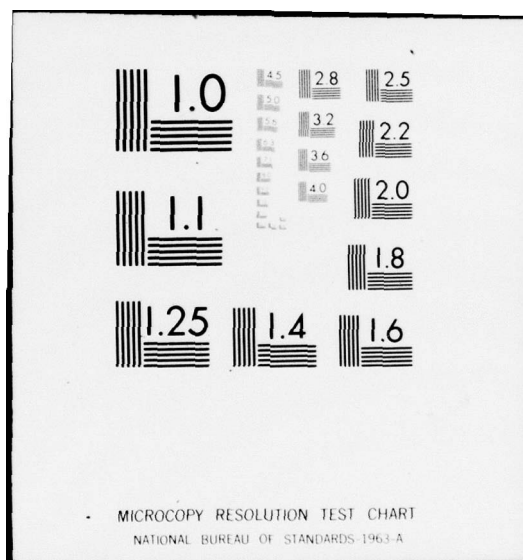
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A method for the microbial de- contamination of water in ultrasonic scalers and high speed handpieces was devel- oped. Baseline water samples from ultrasonic scaler averaged $4.99 \times 10^5$ colony forming units/ml. After initial filtration with $3.0 \mu\text{m}$ pore size capsule filters counts decreased to a mean of $1.73 \times 10^4$ . Disposable $.45 \mu\text{m}$ pore size cellulose acetate filter units were used as secondary filters and installed at the ultra- sonic scaler handpieces and at the connections of high speed handpieces. The use of these filters, together with the sterilization of the waterlines resulted in elimination of microflora from the water of ultrasonic scalers for up to 48 hours.		

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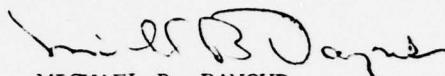
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MICHAEL B. DAYOUB  
LTC, DC  
Division of Oral Biology

7 September 1977 (26 Aug 77)


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A METHOD OF DECONTAMINATION OF  
ULTRASONIC SCALERS AND HIGH SPEED HANDPIECES

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A METHOD OF DECONTAMINATION OF  
ULTRASONIC SCALERS AND HIGH SPEED HANDPIECES



The deleterious effects of bacterial contamination of wounds during dental procedures and the transmission of infectious diseases to patients in dental operatories are difficult to demonstrate but circumstantial evidence implicating these dangers exists.<sup>1-3</sup> In the past, little emphasis has been placed on asepsis in dental operative or surgical procedures, partly because of the presence of a large population of resident microflora in the oral cavity. Now, the reduction of physical and biologic hazards to dentists and their patients is possible and is of continuing interest. Possible sources of microbial dissemination in dental operatories and the contamination of waterlines in dental equipment have been pointed out repeatedly.<sup>3-6</sup> Recently, attention has been focused again at the high numbers of organisms found in the waterlines of dental units and ultrasonic scalers and partially successful decontamination procedures have been recommended.<sup>7</sup> This study was undertaken to investigate a filtration method for decontamination of the water from ultrasonic scalers and high speed handpieces.

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## MATERIALS AND METHODS

A modification of previously described methods<sup>4,7</sup> was utilized to sample a communal water supply after passage through ultrasonic scalers\* and high speed handpieces.†

### 1. Ultrasonic Scalers

To determine the extent of contamination of an ultrasonic scaler which had been in routine use, the water from the scaler handpiece was tested daily for six days.

Tests of water decontamination by filtration under laboratory conditions were performed in the following way. A 3.0 $\mu$ m pore size pleated membrane capsule filter‡ was used as a pre-filter, or primary filter, and was attached between a communal water supply and the water inlet to an ultrasonic scaler (Fig. 1). As a secondary filter, a .45 $\mu$ m pore size, sterile, disposable cellulose acetate filter unit§ was installed approximately 10cm from the scaler handpiece. The filter unit was attached to the water tubing using 14 or 18 gauge hypodermic needles and an adapter fabricated by joining two Luer Lok syringe tips with a glass tube 1cm in length (Fig.2). Before placing the secondary filter, the scaler handpiece

\* Cavitron, Cavitron Ultrasonics, Inc., Long Island City, N.Y.

† Starlite, Star Dental Manufacturing Co., Inc., Conshohocken, Pa.

‡ Gelman Instrument Co., Ann Arbor, Mich.

§ Millex. Millipore Corporation, Bedford, Mass.



and hose were autoclaved at 15 PSI and 121°C for 20 minutes. Water samples were taken from the lumen of the water tubing before connection to the secondary filter and from the end of the handpiece at 0, 4, 8, 24, 32, 48, 52 and 56 hours. The handpiece was covered with a sterile metal test tube cap between sampling times.

In a test of filter use in a clinical environment, the 3.0 $\mu$ m pore size capsule filter was installed into the water supply of a dental unit\* which was used routinely in the practice of general dentistry. The same ultrasonic scaler with the 45 $\mu$ m filter, was attached to the dental unit and the water sampled before secondary filtration and at the end of the handpiece at 0, 4, 8, 24, 32, and 48 hours. During this test sterile scaler inserts and hoses, and aseptic techniques were again used.

In the second clinical test investigating the decontamination of water from ultrasonic scalers, the samples were taken from the same ultrasonic scaler at the time intervals indicated above. As in the first clinical testing, the hose, handpiece, and insert were sterilized at the beginning of each trial. However, the unit was used in a routine manner, without special emphasis on sterile techniques or special handling of the inserts after their removal from sterile packages.

Each test of water filtration in ultrasonic scalers was performed four times.

\* Midwest American, Melrose Park, Ill.

## 2. High Speed Handpieces

To test the feasibility of decontamination of the waterlines of a high speed handpiece, the waterline to the handpiece was fitted with the disposable .45 $\mu$ m filter unit approximately 10cm from the handpiece. Fourteen gauge, four inch, laboratory cannulas, used with the previously described adapter served as connections between the waterline and the filter unit (Fig 3). Prior to filter installation the waterline between the filter unit and the handpiece was filled with 2% glutaraldehyde\* for 16 hours and drained afterward. The handpiece was sterilized by alcohol vapor sterilization.† The handpiece was in routine clinical use and was wiped with alcohol soaked sponges after use and covered with sterile gauze when not in use. Water samples were taken from the end of the tubing to be connected to the filter assembly and from the handpiece spray after filter insertion at 0, 24, 48, 72, and 96 hours. This test was performed on five occasions.

Throughout all experiments, during each water sampling approximately 2ml of water was aseptically collected. All samples were serially diluted using sterile tap water, and 0.1ml aliquots of the dilutions were plated in triplicate on

\* Cidex, Arbroom, Inc., Arlington, Texas

† Harvey 4000 Chemiclave, MDT Corporation, Gardena, Calif.

Trypticase Soy Agar\* plates and cultured aerobically for seven days at 37°C. Colony forming units (CFU) were then counted and averaged.

## RESULTS

Water samples obtained from an unmodified ultrasonic scaler on six different days showed a range of  $4.81 \times 10^4$  to  $1.32 \times 10^6$  CFU/ml water with a mean of  $4.99 \times 10^5$ . When a  $3.0 \mu\text{m}$  capsule filter was attached to the water inlet of an ultrasonic scaler to accomplish preliminary or primary filtration, the bacterial counts during four trials ranged from  $2.20 \times 10^2$  to  $6.74 \times 10^4$ /ml (Table 1) with a mean of  $1.73 \times 10^4$ .

Water samples from the scaler handpiece, after passing the  $.45 \mu\text{m}$  secondary filter showed no bacterial growth at 32 hours, and at 48 hours no bacteria could be detected in three of the four trials. At 52 hours all samples were contaminated. The bacterial counts, however, were lower than those at 52 hours after preliminary filtration.

In the clinical test of filtration under controlled conditions using strictly aseptic techniques there was no evidence of contamination up to 48 hours during three trials (Table 2). The fourth trial, although successful up to 32 hours, showed bacterial contamination of  $1.60 \times 10^2$  CFU/ml at

\* Difco Laboratories, Inc., Detroit, Mich.

48 hours.

The last four clinical trials, performed under routine clinical conditions in which aseptic techniques were not strictly enforced during ultrasonic scaler use (Table 3), showed contamination occurring within 48 hours during the first trial, within 28 hours on the third trial, and within 4 hours on the second and fourth trials.

When the water to a high speed handpiece was passed through the .45 $\mu$ m filter, no bacterial growth in water samples could be demonstrated during the first 48 hours in three of five trials (Table 4). However, in the fourth and fifth trials, recontamination of the water occurred after 24 and 48 hours respectively.

#### DISCUSSION

Water from dental units is used routinely during various dental procedures and frequently for drinking purposes. Definite standards for limits of bacterial contamination of drinking water, except for the coliforms counts, are not known. It is held, however, that total colony counts of over 200/ml of treated water and 500/ml of raw water should be considered indicative of contamination and render such water unfit for drinking.<sup>12</sup> The results of our study of the degree of contamination of waterlines in dental units and ultrasonic scalers before filter installation and sterilization of



hoses, are in agreement with results reported by others.<sup>1,4-7</sup>

The use of contaminated water from the dental armamentarium may be hazardous when it is allowed to contact open wounds. This usually occurs when ultrasonic scalers and high speed handpieces are used during surgical procedures. Although untoward sequelae as a result of these procedures with bacteria-laden water are difficult to demonstrate, the decontamination of the water supply of these devices is considered to be important and necessary.

Our results have shown that water in ultrasonic scalers may be effectively decontaminated by filtration. Our data also indicates that even when a 3.0 $\mu$ m pore size filter is used in order to remove particulate matter, some reduction in the microbial flora of water occurs.

This reduction in bacterial counts after installation of 3.0 $\mu$ m filter may have occurred because of two reasons:

1. Some of the organisms present in the water supply may be trapped by smaller pores of the filter or simply adsorbed to the filter surface, or

2. Bacteria colonizing the inner surface of the water tubing in the scaler hoses have been killed by sterilization of these hoses at the beginning of each trial.

The presence of very high numbers of microorganisms in dental units' water supply has been ascribed to bacterial colonization of long narrow water tubing of the dental units.<sup>2,4-6</sup>



Water flow through the ultrasonic scaler or through the dental unit did not noticeably decrease when a 3.0 $\mu$ m pore size capsule filter was used. Filtration by the .45 $\mu$ m filter units produced a noticeable decrease in water flow. However, adequate flow was maintained during the period of these tests. Under laboratory conditions a flow judged to be adequate was maintained for 30 minutes of continuous ultrasonic scaler operation at maximum water flow settings. This 30 minute period may appear too short and may necessitate filter changes more than once each day in many practices. However, other filter types or increased water pressures could make fewer filter changes possible. In pilot studies in the laboratory, 0.2 $\mu$ m pore size pleated membrane capsule filters or .22 $\mu$ m disposable cellulose acetate filter units, when connected to water lines, restricted flow to unacceptable levels.

In this study, when the water tubings of ultrasonic scalers were fitted with 14 gauge needles as connectors to the .45 $\mu$ m filter unit, the water tubings became unusable after undergoing approximately seven sterilization cycles of autoclaving. The damage to the tubing was manifested by splitting of the tubing which was probably caused by the pressure of forceful insertion of the needles into the tubing followed by the steam sterilization process. Replacement of the hoses

was then necessary. When an entire hose to an ultrasonic handpiece was not modified, it withstood 403 cycles of autoclaving before it became unusable. Although the system of filtration used in this study was believed to be of value, it lacked the durability necessary for use in routine dental practice. Manufacturers should be encouraged to develop reliable systems with easily changed disposable filters using water tubings which resist deterioration by steam or chemical sterilization processes.

In view of evidence implicating waterborne organisms such as the *Pseudomonas* and *Flavobacterium* species, in endocarditis,<sup>8,9</sup> the use of uncontaminated water supplies becomes more important. Although the organisms found in waterlines are usually considered to be non-pathogens, the potential for infection of debilitated or immunosuppressed patients by these organisms has been recognized.<sup>2,10,11</sup> During and after oral surgical procedures, the inhalation of infectious material can occur and can lead to infection when the protecting mechanisms are ineffective.<sup>10</sup> This could be highly significant when one considers the common practice of using water from ultrasonic scalers or high speed handpieces which becomes aerosolized. The foregoing facts should be the basis for future research to substantiate the potential hazards and to develop methods for the effective decontamination of water supplies.

SUMMARY

The use of contaminated water in high speed handpieces and ultrasonic handpieces presents potential hazards to both dentist and patient. This study has shown that after waterline sterilization, the use of a sterile, disposable membrane filter can eliminate the microflora from the water of an ultrasonic scaler for up to 48 hours. Similarly, the water from a high speed handpiece can remain bacteria free for up to 72 hours when a .45 $\mu$ m pore size membrane filter is installed into the waterline. This system of decontamination by filtration may present a workable approach to the problem of contaminated water and merits further research and development.

Commercial materials and equipment are identified in this report to specify the investigative procedures. Such identification does not imply recommendation or endorsement or that the materials and equipment are necessarily the best available for the purpose. Furthermore, the opinions expressed herein are those of the author and are not to be construed as those of the Army Medical Department.

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TABLE 1. Bacterial Counts (CFU/ml) in Water from Ultrasonic Scalers Following Filtration and the Use of Aseptic Techniques Under Controlled Laboratory Conditions

TIME (hours)	TRIALS							
	1		2		3		4	
	PF*	SF†	PF	SF	PF	SF	PF	SF
0	$3.40 \times 10^3$	0	$2.70 \times 10^2$	0	$2.20 \times 10^2$	0	$2.74 \times 10^3$	0
4	$2.41 \times 10^3$	0	$1.30 \times 10^3$	0	$3.21 \times 10^3$	0	$1.01 \times 10^4$	0
8	$8.26 \times 10^2$	0	$1.05 \times 10^3$	0	$2.05 \times 10^4$	0	$6.37 \times 10^3$	0
24	$1.24 \times 10^3$	0	$4.90 \times 10^3$	0	$3.98 \times 10^4$	0	$1.92 \times 10^4$	0
28	$1.10 \times 10^3$	0	$2.63 \times 10^3$	0	$5.24 \times 10^4$	0	$2.20 \times 10^4$	0
32	$1.66 \times 10^3$	0	$5.23 \times 10^3$	0	$6.73 \times 10^4$	0	$2.69 \times 10^4$	0
48	$7.80 \times 10^3$	0	$5.20 \times 10^3$	0	$5.87 \times 10^4$	$1.27 \times 10^3$	$2.38 \times 10^4$	0
52	$5.80 \times 10^3$	$1.33 \times 10^2$	$6.43 \times 10^3$	$1.95 \times 10^3$	$5.68 \times 10^4$	$5.23 \times 10^2$	$2.23 \times 10^4$	$9.50 \times 10^2$
56	$2.06 \times 10^3$	$2.33 \times 10^2$	$5.66 \times 10^3$	$3.63 \times 10^2$	$6.74 \times 10^4$	$7.33 \times 10^2$	$2.23 \times 10^4$	$1.79 \times 10^3$

\* After passing 3.0µm primary filter and before secondary filtration.

† After passing 3.0µm primary filter and .45µm secondary filter.



TABLE 2. Bacterial Counts (CFU/ml) in Water from Ultrasonic Sclers Following Filtration and the Use of Aseptic Techniques Under Controlled Clinical Conditions

TIME (hours)	TRIALS							
	1				2			
	PF*	SF†	PF	SF	PF	SF	PF	SF
0	$2.06 \times 10^3$	0	$2.73 \times 10^4$	0	$1.94 \times 10^4$	0	$2.46 \times 10^4$	0
4	$4.36 \times 10^3$	0	$1.85 \times 10^4$	0	$1.25 \times 10^3$	0	$1.52 \times 10^3$	0
8	$4.83 \times 10^3$	0	$3.01 \times 10^4$	0	$2.00 \times 10^3$	0	$5.13 \times 10^4$	0
24	$1.35 \times 10^4$	0	$5.80 \times 10^4$	0	$2.16 \times 10^3$	0	$7.90 \times 10^4$	0
28	$4.40 \times 10^4$	0	$3.80 \times 10^4$	0	$1.15 \times 10^4$	0	$1.50 \times 10^5$	0
32	$7.56 \times 10^4$	0	$1.62 \times 10^5$	0	$5.26 \times 10^4$	0	$1.50 \times 10^5$	0
48	$4.38 \times 10^5$	0	$1.13 \times 10^6$	0	$6.60 \times 10^5$	0	$1.03 \times 10^6$	$1.60 \times 10^2$

\* After passing 3.0µm primary filter and before secondary filtration.

† After passing 3.0µm primary filter and .45µm secondary filter.

TABLE 3. Bacterial Counts (CFU/ml) of Filtered\* Water from Ultrasonic  
Scalers Under Routine Clinical Conditions

TIME (hours)	TRIALS			
	1	2	3	4
0	0	0	0	0
4	0	$2.05 \times 10^2$	0	$2.66 \times 10^2$
8				$1.11 \times 10^2$
24	0	$2.33 \times 10^2$	0	$5.25 \times 10^2$
28			$1.66 \times 10^2$	$2.21 \times 10^2$
32	0	$2.00 \times 10^3$		$7.63 \times 10^2$
48	$2.10 \times 10^2$	$9.93 \cdot 10^3$	$7.00 \times 10^1$	$4.18 \times 10^3$

\*After filtration through  $3.0\mu\text{m}$  primary filter and  $.45\mu\text{m}$  secondary filter.

TABLE 4. Effect of Filtration\* on Microbial Concentration (CFU/ml) in  
Water from a High Speed Handpiece Used Under Routine Conditions

TIME (hours)	TRIALS				
	1	2	3	4	5
0	0	0	0	0	0
24	0	0	0	$2.71 \times 10^3$	0
48	0	0	0	TNTC †	$2.43 \times 10^2$
72	$7.20 \times 10^1$	0	$3.87 \times 10^3$	TNTC	TNTC
96	$1.65 \times 10^2$	TNTC	$5.45 \times 10^3$	TNTC	TNTC

\*After filtration through .45 $\mu$ m cellulose acetate filter.

†Too numerous to count at dilution performed.

## LEGENDS

- Figure 1. Pleated membrane, 3.0 $\mu$ m pore size, capsule filter attached to the water inlet of an ultrasonic scaler as the primary filter.
- Figure 2. Disposable .45 $\mu$ m pore size cellulose acetate filter unit used as a secondary filter.
- Figure 3. Disposable .45 $\mu$ m pore size disposable cellulose acetate filter unit attached to high speed handpiece.

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FIGURE 1.



FIGURE 2

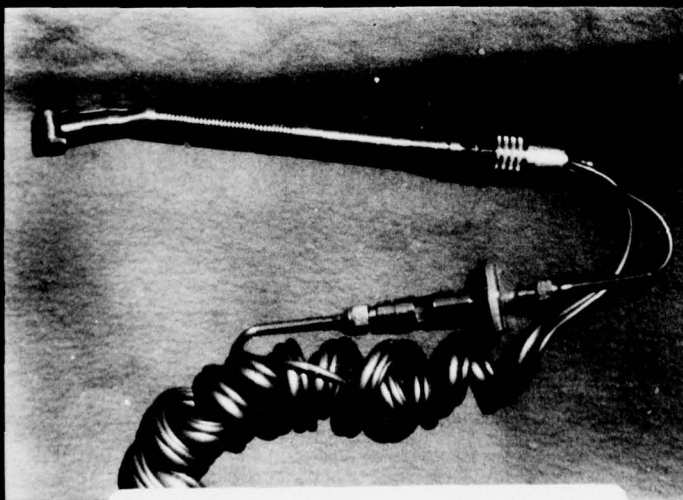


FIGURE 3

